Human Computer Interaction
CS449 – CS549

Week 11

Measuring UX Methods

KÜRŞAT ÇAĞILTAY

Reminder - Due dates - Revised

- Assignment-5 Gesture based system - December 10 - Tuesday
- Assignment-6 End user based Usability testing of «Assignment-5» - December 17 - Tuesday

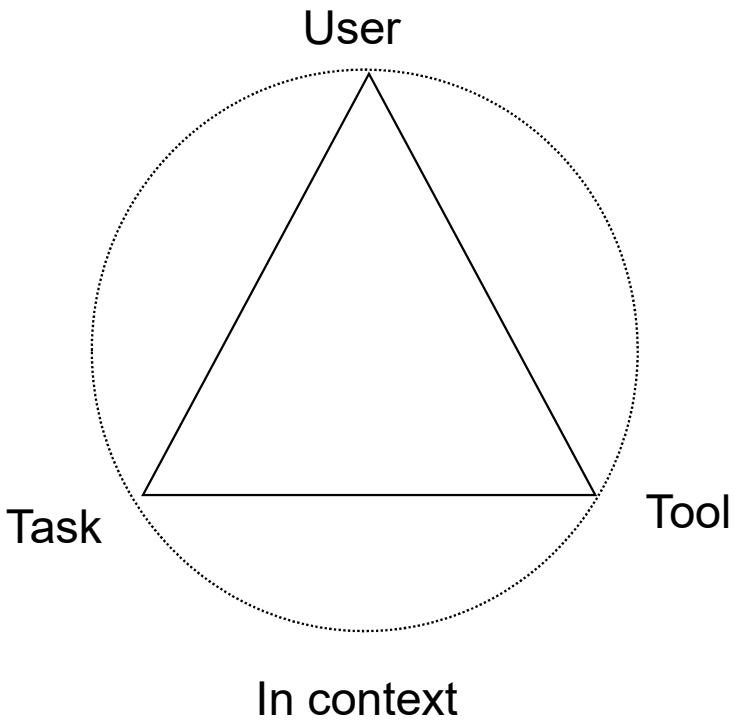
- Draft Term project/proposal December 23 – Monday (I strongly suggest you finish it early) – Contact me for your topic
- Term project submission January 10 - Friday

Term Project Groups?

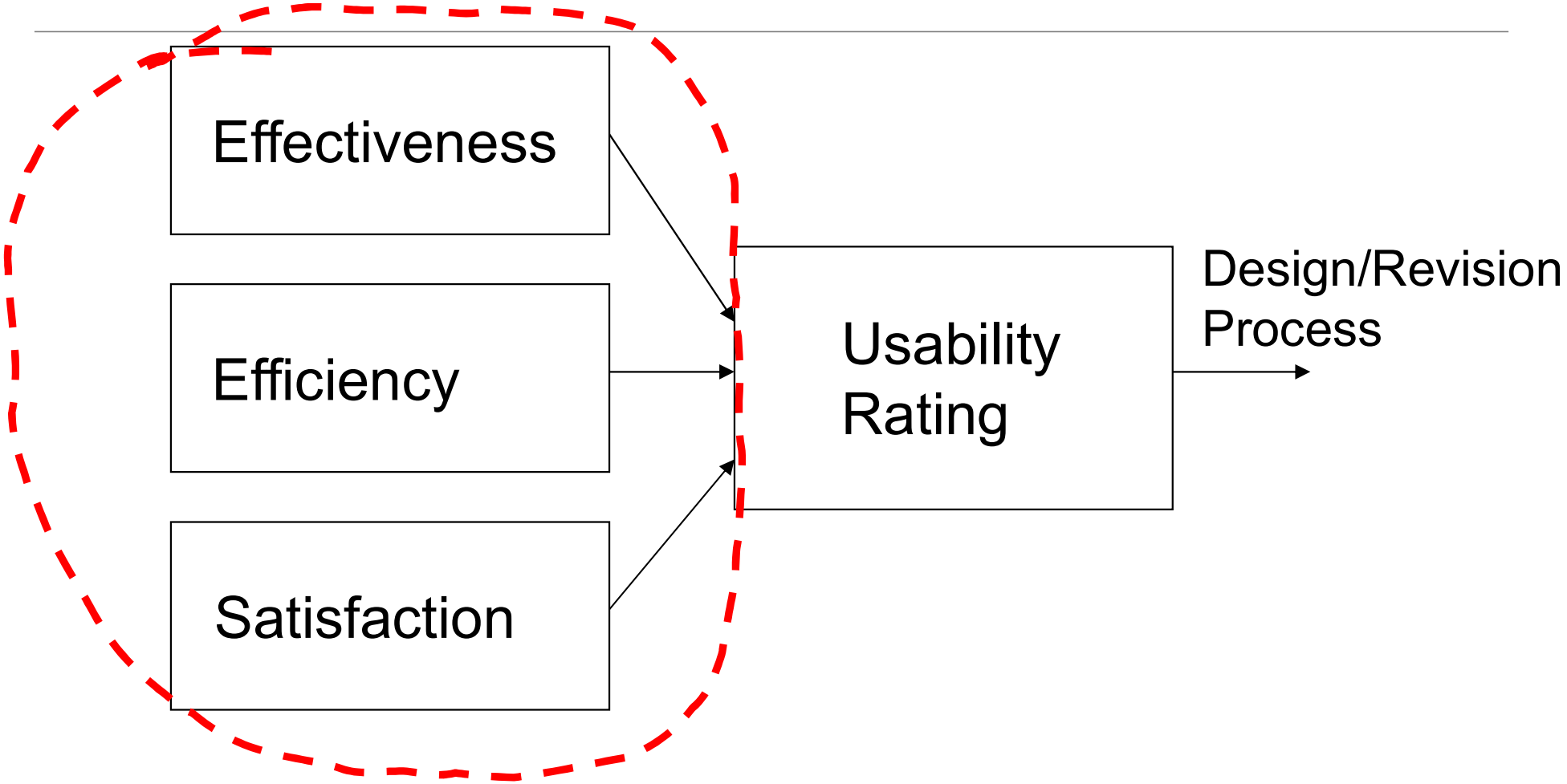
- https://docs.google.com/spreadsheets/d/13NXBXdie9sRplnmM7g20hy1IXFACs2ppr9W-jtmRbtE/edit?gid=980975006#gid=980975006

Method

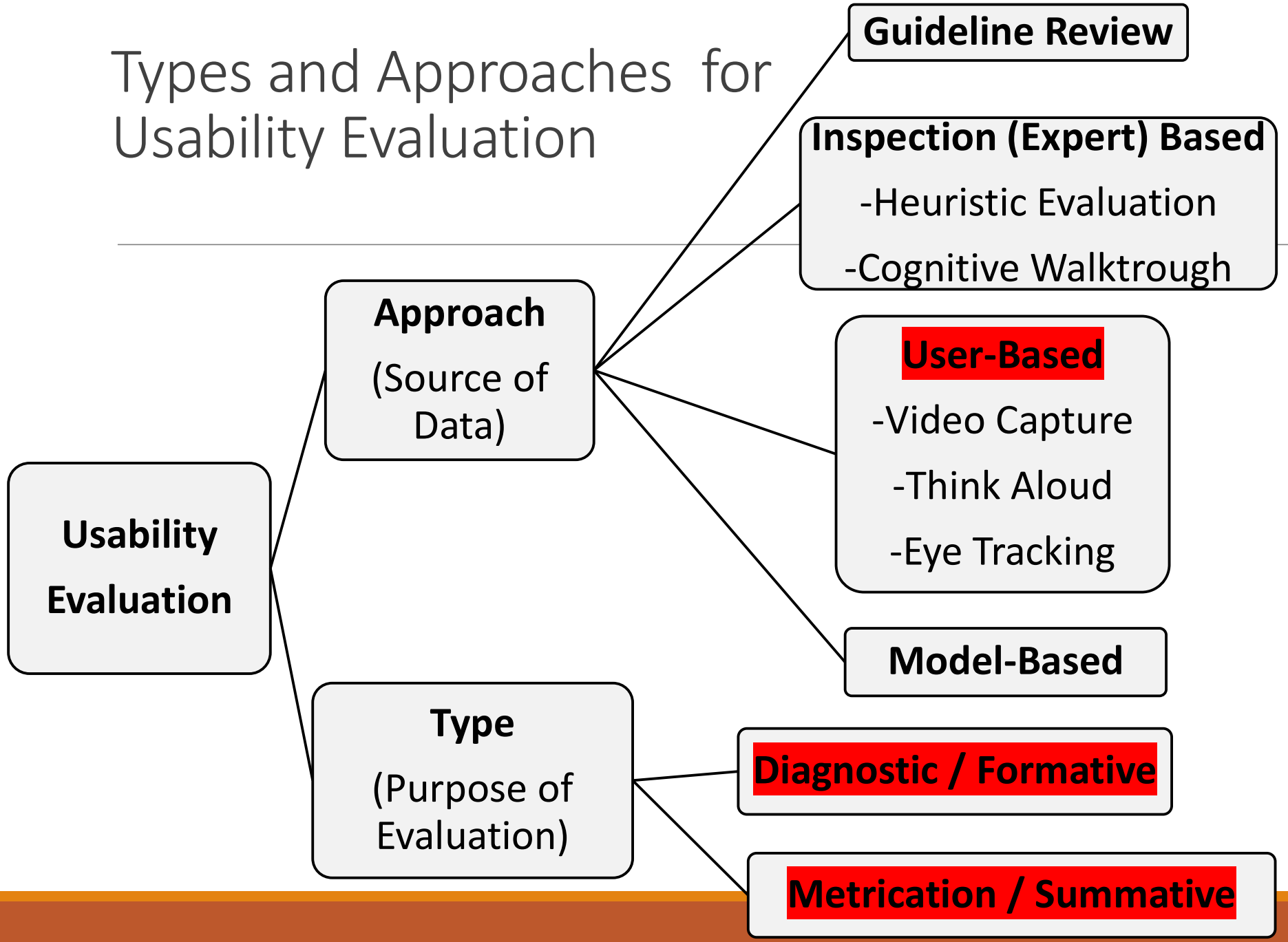
- Users
- Tasks
- Situation/Context
- Tool



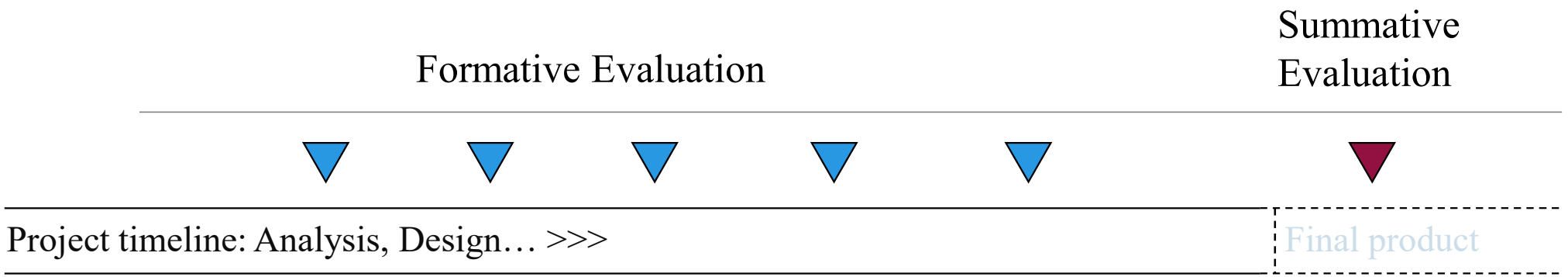
Determinants of usability rating



Types and Approaches for Usability Evaluation

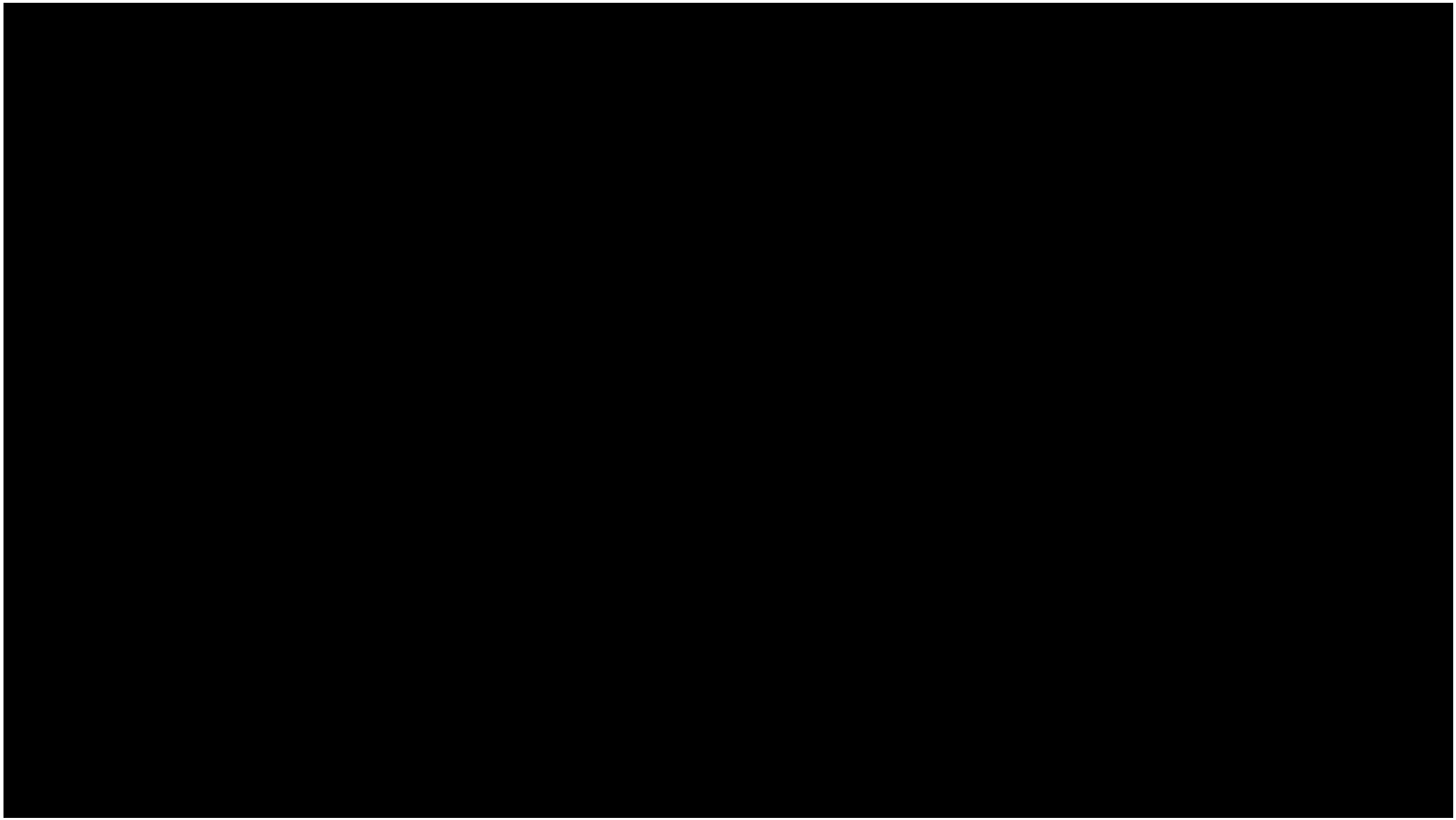


Evaluation Type

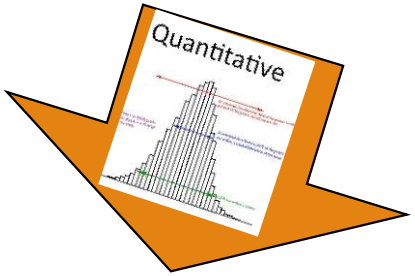


User Based Testing

User Based Testing

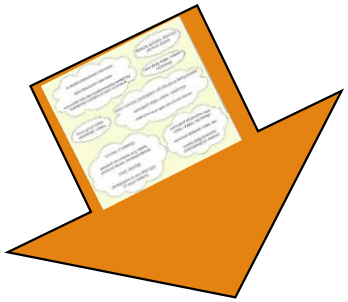


Research Methods: Data Collection



Quantitative Methods (Statistics)

- Efficiency
- Effectiveness
- Satisfaction

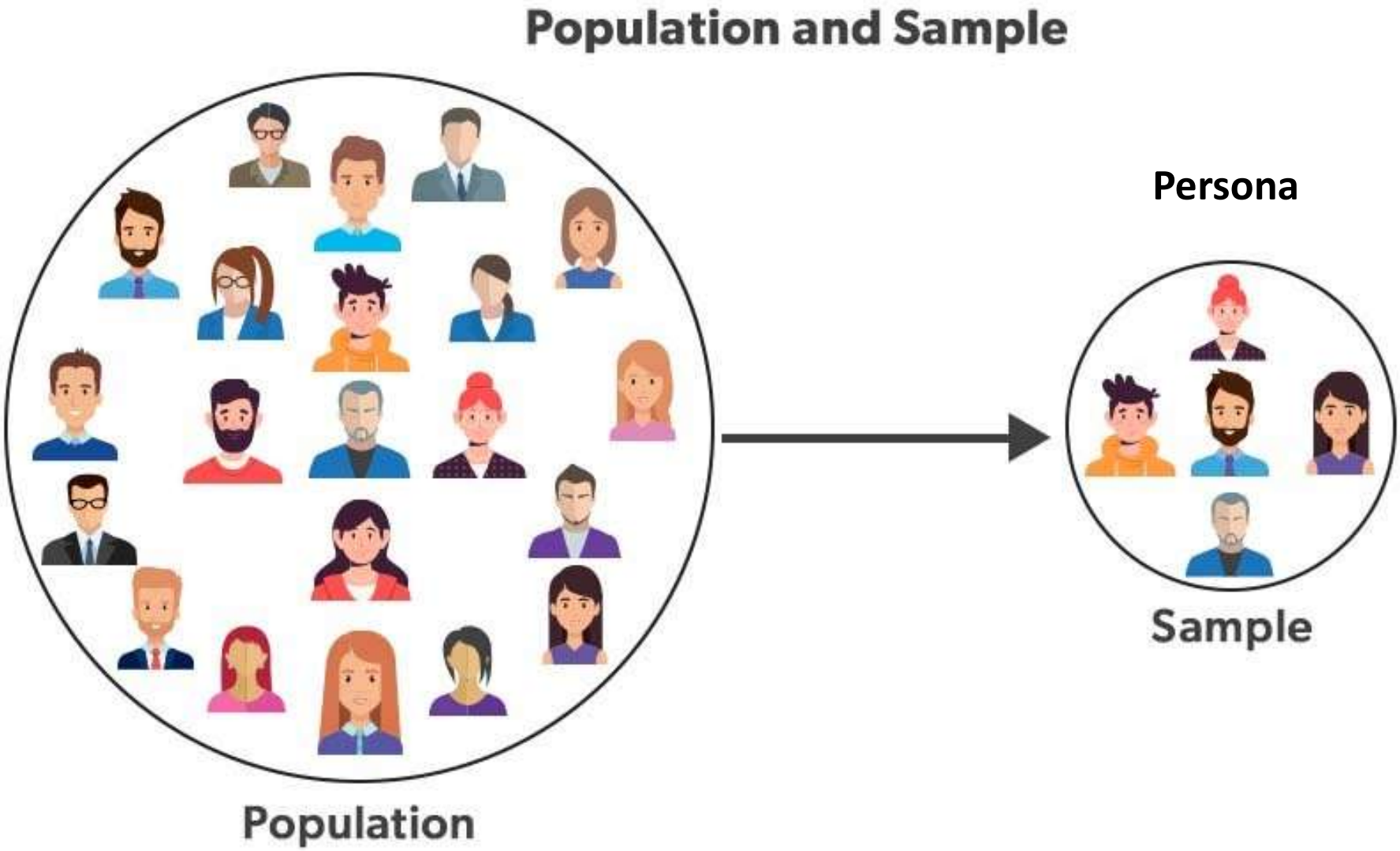


Qualitative Methods (Verbal - Mostly)

- Satisfaction

Empirical Studies

- To understand cause and effect
  - "When small size buttons are used, it decreases likelihood of completing a purchase"
- To make predictions
  - "When users type on a new keyboard, their typing speed increases."
- To test hypotheses
  - "There is no performance difference between reading from paper and screen."


Population and Sample
Persona
Sample
Population

Hypothesis: *“My new keyboard is easy to use”*

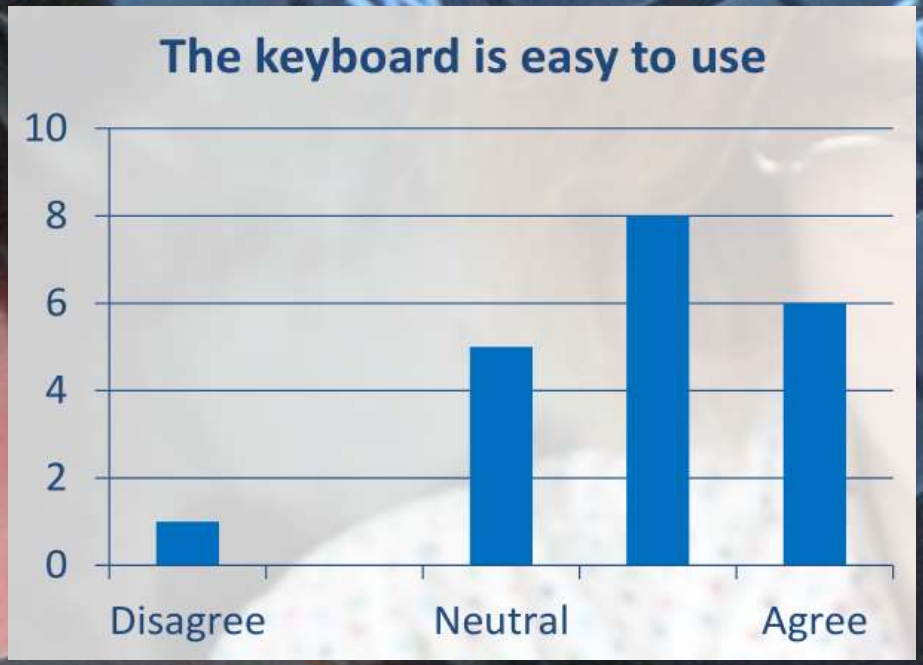


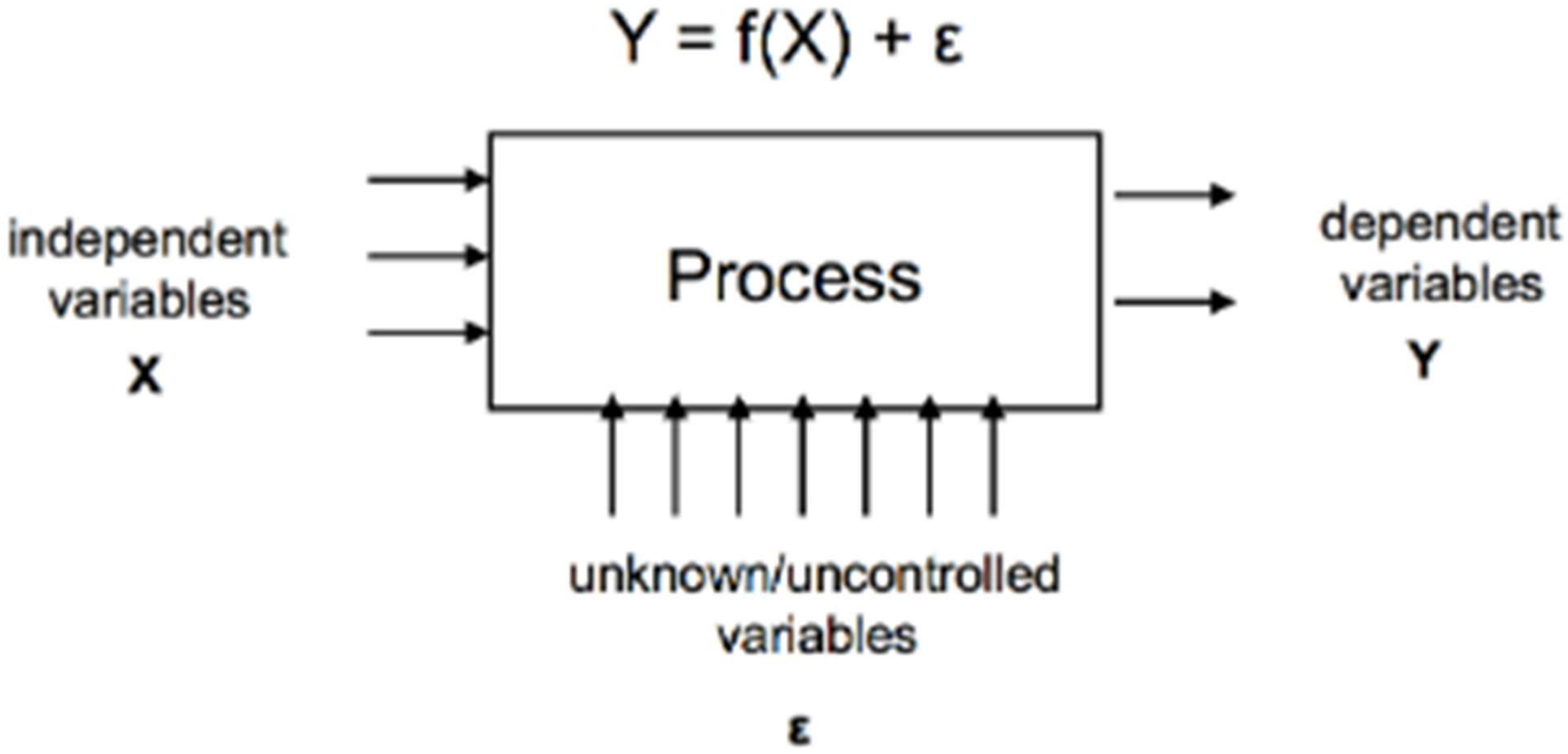
Photo by Niels Henze

Observation vs Controlled Experiments?

- Participants rated the system easy to use, because
  - they actually find the system easy to use?
  - they want to make you happy in your research?

- Knowing the reason for our observation helps us predict things about the world
  - But a mere observation will not help to find the answer!

UX Experiment Design

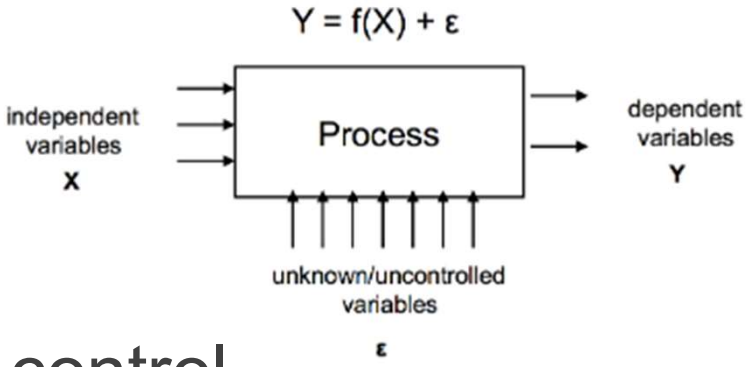


Controlled Experiments

- Controlled experiments are means to isolate cause and effect

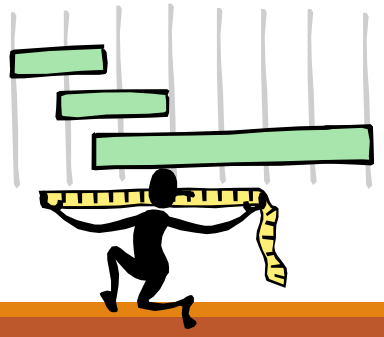
- What if there are potential two effects or if they potentially depend on each other?

Experimental Variables



- Independent Variables (IV) : the ones you control
  - Aspects of the interface design (e.g. Color, Menu size)
  - Characteristics of the testers (e.g. Male/Female,)
  - Continuous: Time between clicks for double-click

- Dependent Variables (DV) : the ones you measure
  - Efficiency & Effectiveness
  - Time to complete tasks
  - Number of errors
  - Satisfaction Scores



Descriptive vs. Inferential

- Descriptive statistics
  - Summarize a group of numbers from a research
- Inferential statistics
  - Draw conclusions/make inferences that go beyond the numbers from a research study
  - Determine if a causal relationship exists between the Independent and Dependent Variables

Data analysis and interpretation

descriptive

mean
median
mode
variance
standard deviation

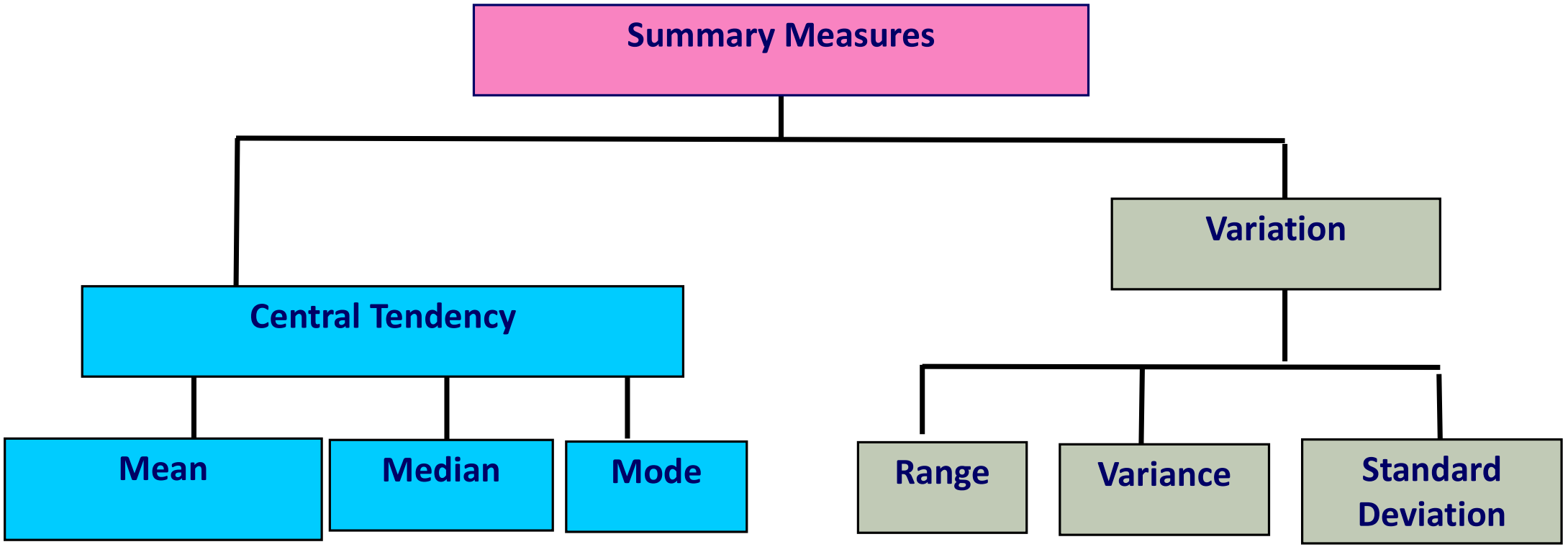
inferential

t-test

analysis of variance

chi squared

Summary Measures



Measures of Central Tendency

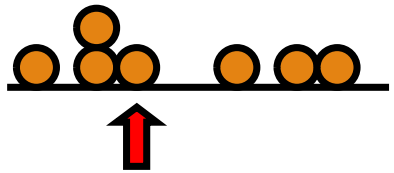
Central Tendency

Average (Mean)

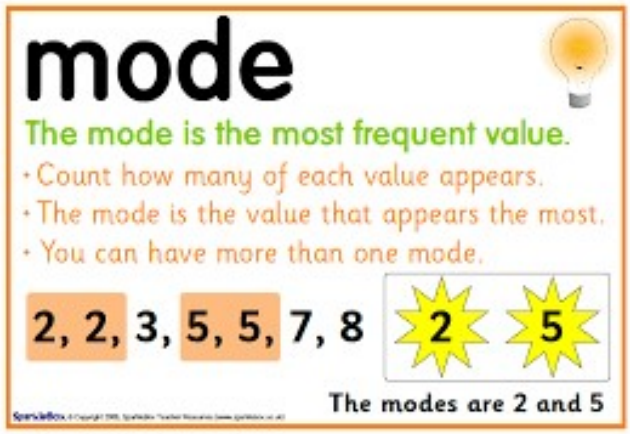
$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$\mu = \frac{\sum_{i=1}^{N} X_i}{N}$$

Median



Mode

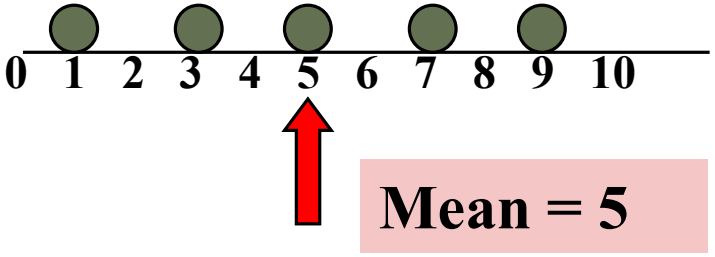


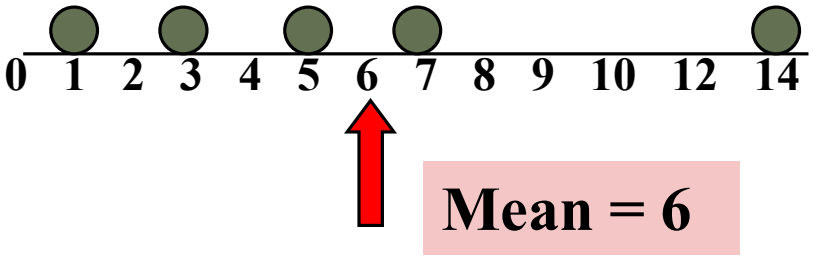
Mean

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

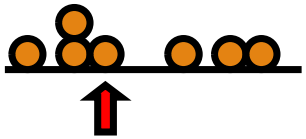
$$\mu = \frac{\sum_{i=1}^{N} X_i}{N}$$

- The most common measure of central tendency
- E.g. Users completed tasks in 2 minutes average
- Affected by extreme values (outliers)

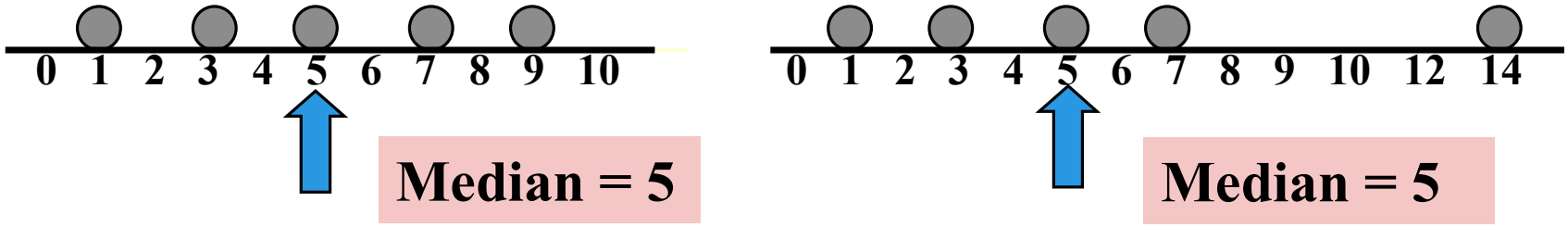




Median - Middle

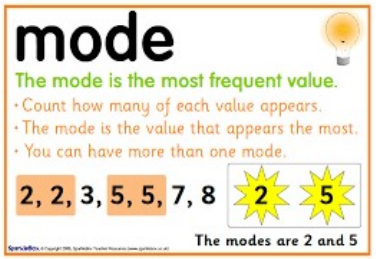


- Robust measure of central tendency
- Not affected by extreme values

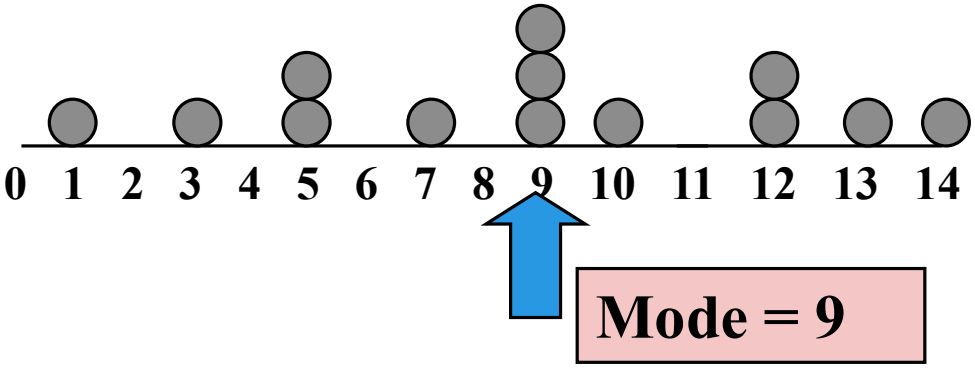


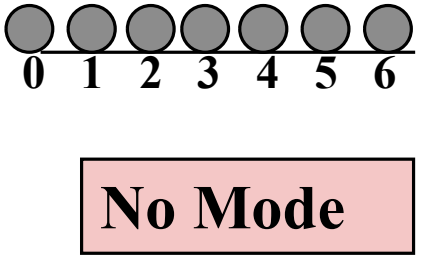
- In an Ordered array, median is the “middle” number

Mode



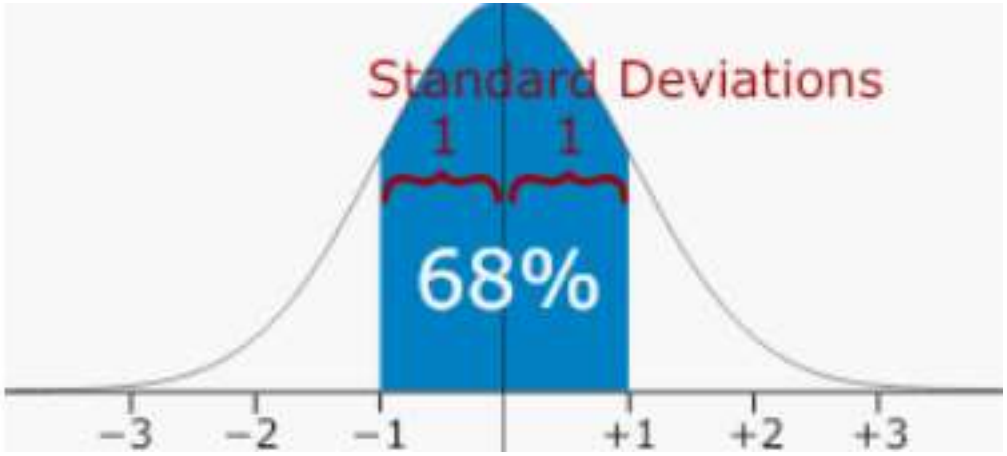
- A measure of central tendency
- Value that occurs most often
- Not affected by extreme values
- Used for either numerical or categorical data
- There may be no/several mode (s)

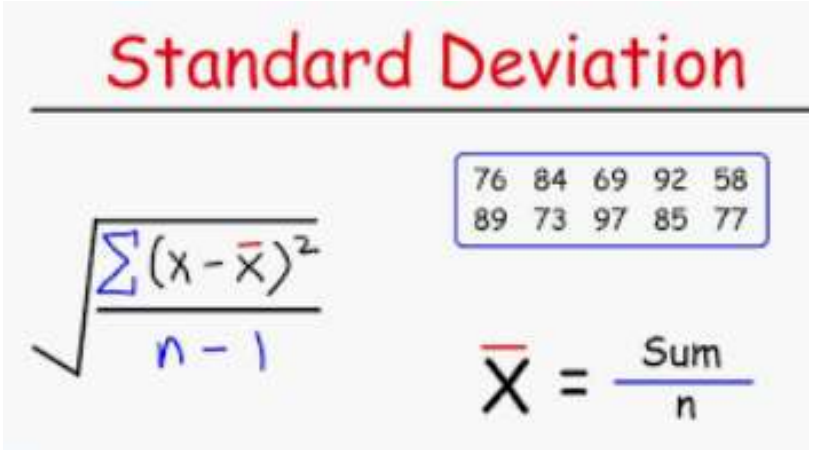




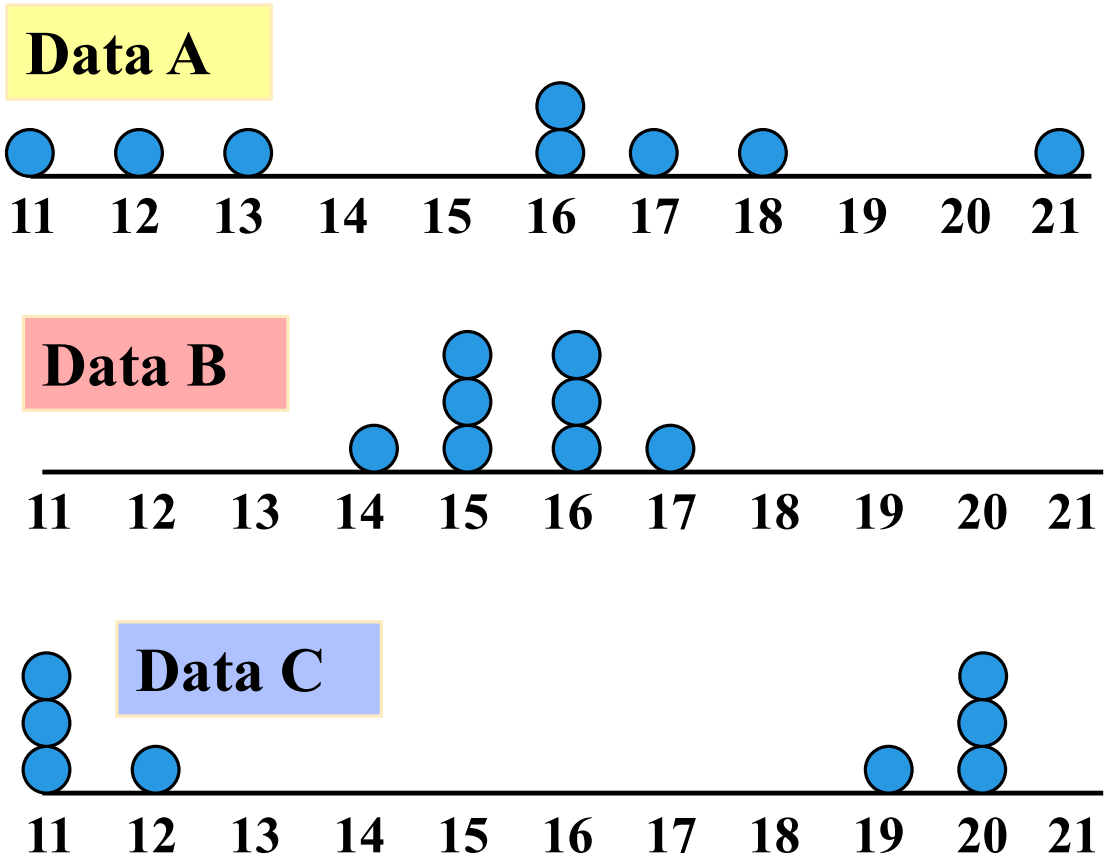
Standard Deviation

…the descriptive statistic indicating the spread of a set of scores around the mean





Comparing Standard Deviations



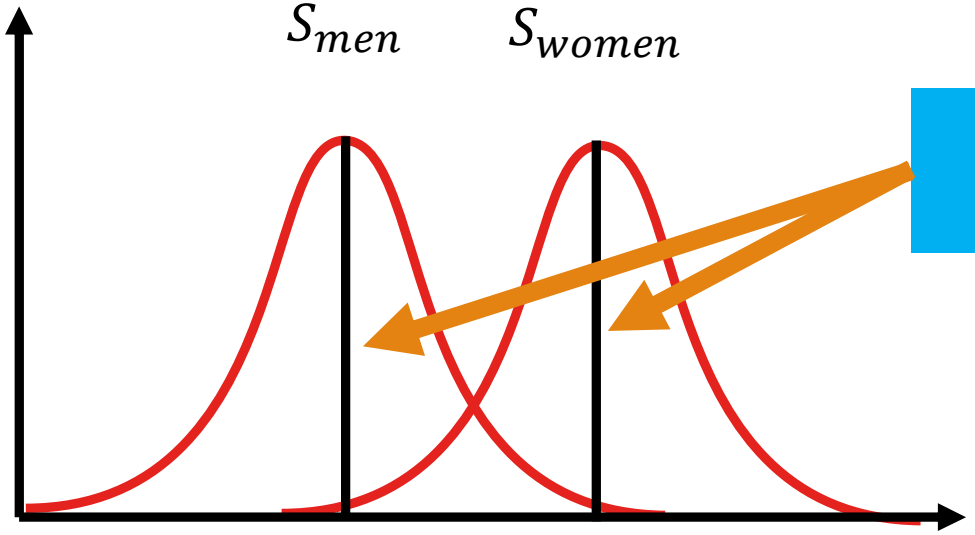
Mean = 15.5
SD = 3.338

Mean = 15.5
SD = .9258

Mean = 15.5
SD = 4.57

Two IVs: Which one is true?

- *There is a difference in typing speed between males and females*
- *There is no difference in typing speed between males and females*



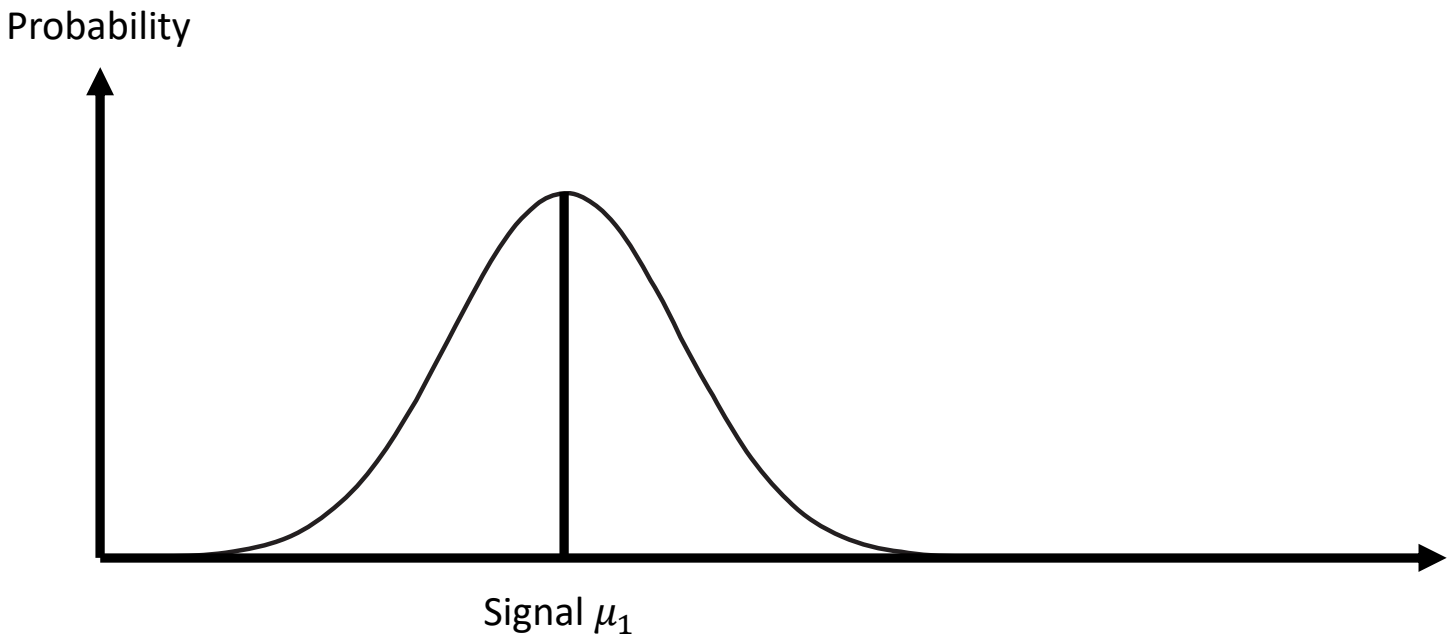
difference statistically significant?

Comparing Means: T-test

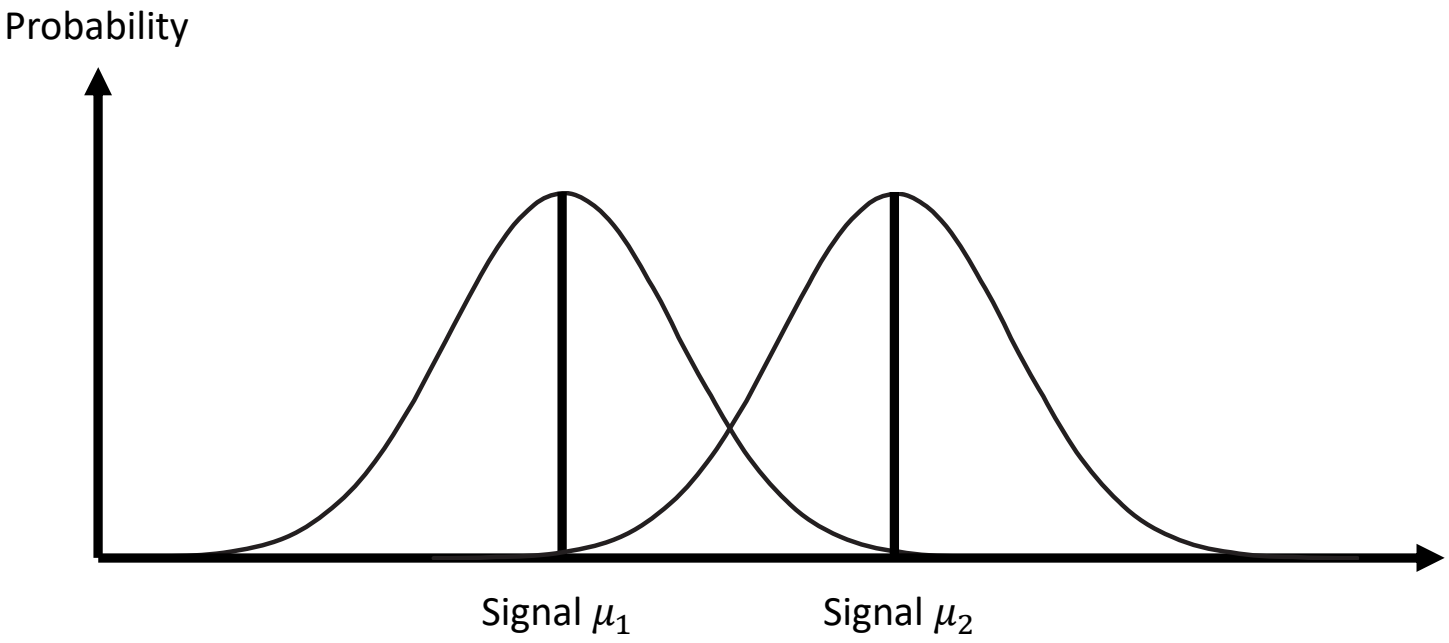
- inferential statistic indicating whether the means of *two* groups are significantly different from one another
- Compare means of dependent variable between **two groups**

- How to make t-test with Excel:
- https://toptipbio.com/t-tests-excel/
- https://www.youtube.com/watch?v=q0ckcKsSPXU

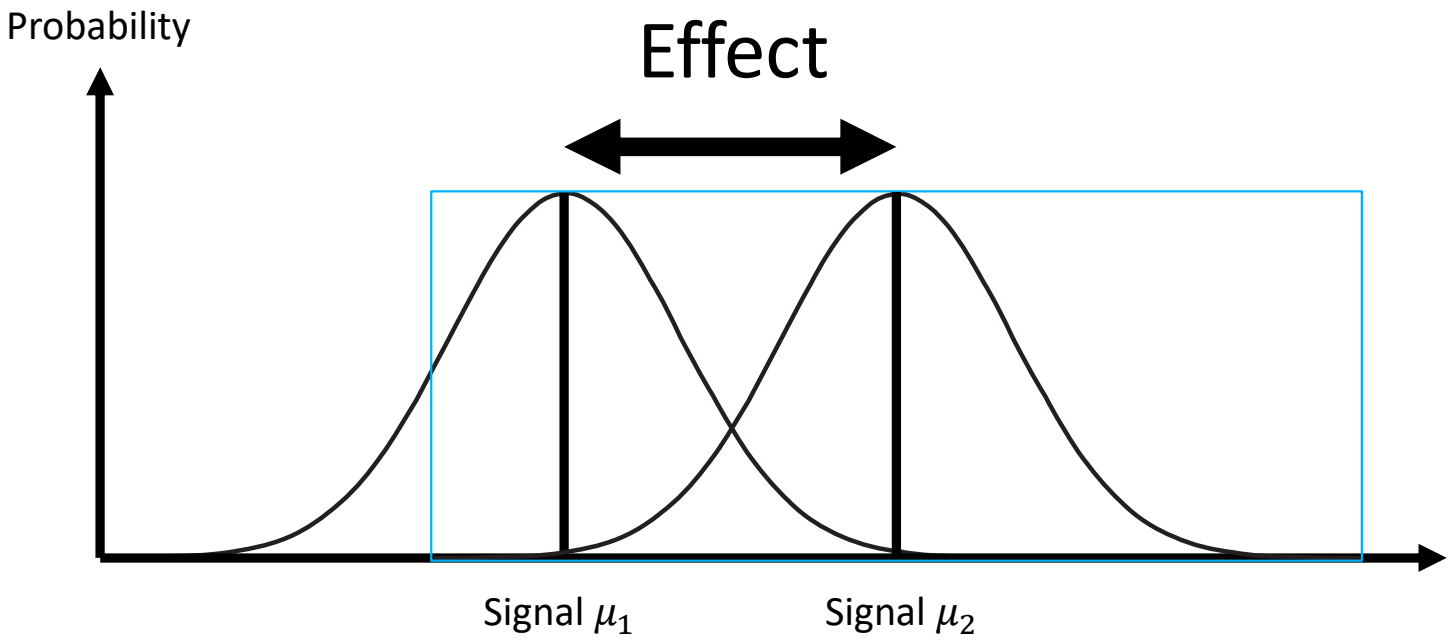
Hypothesis Testing



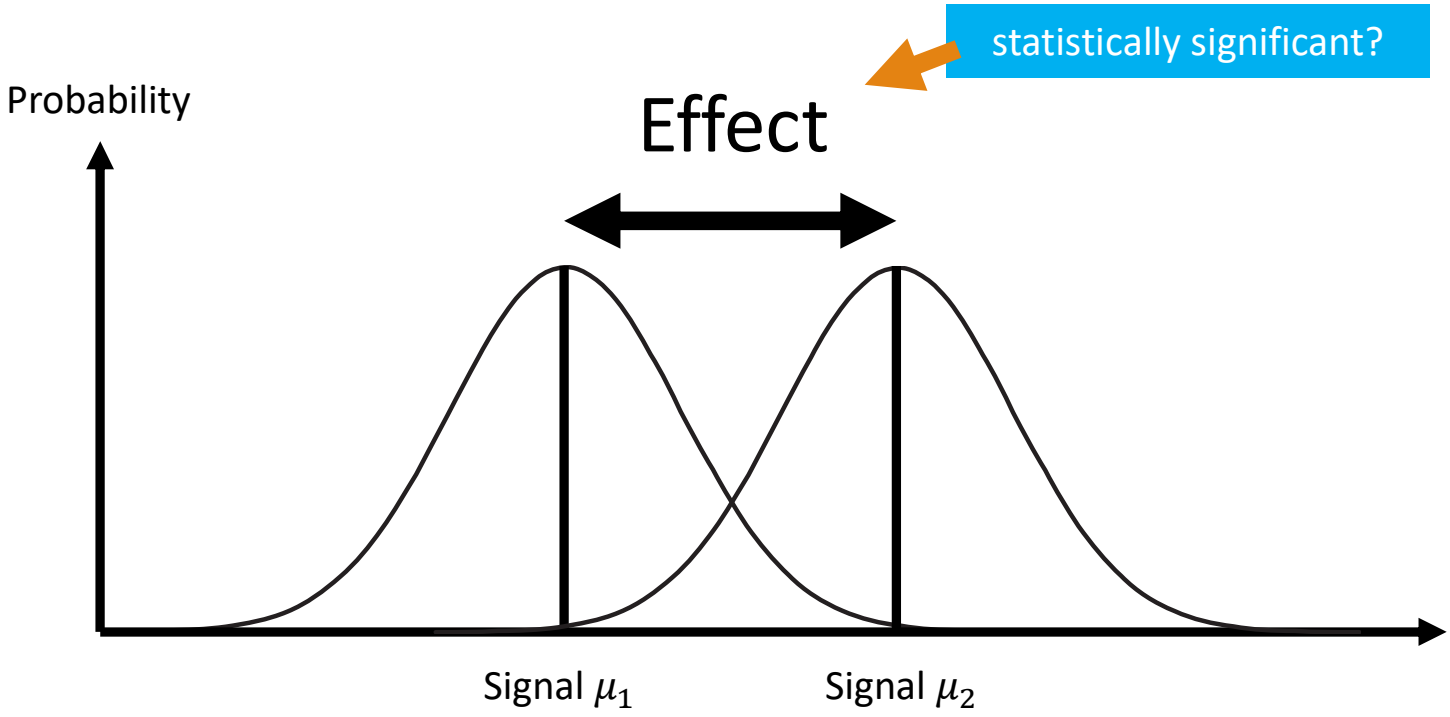
Hypothesis Testing



Hypothesis Testing

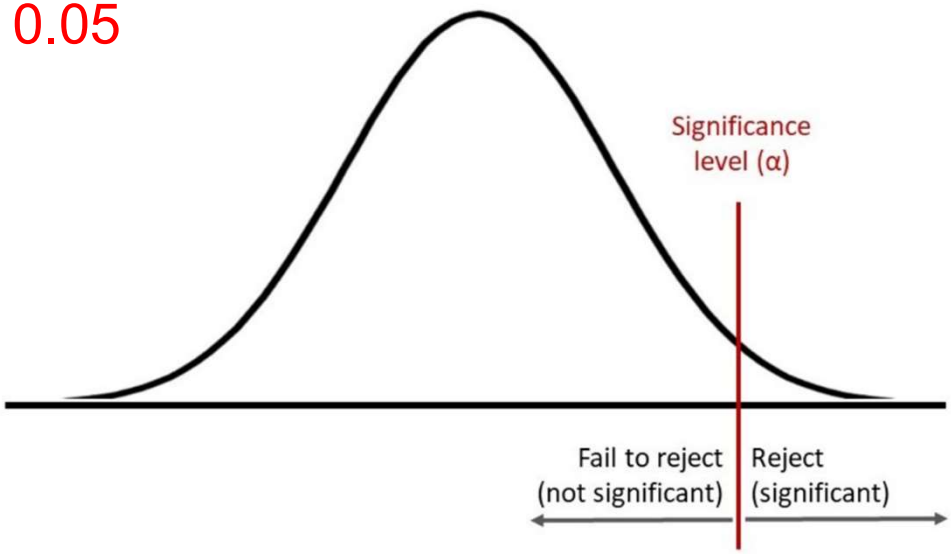


Hypothesis Testing



Statistical Significance **α = 0.05**

- A statistical significant effect exists if the probability that the difference occurred is below a certain significance level
- Significance level (α)
  - Lower significance level means higher evidence
  - Arbitrary, but typical significance level: α = 0.05
- Significant results (p < α)
  - There is a statistical significant difference
- Non-Significant results (p >= α)
  - We cannot conclude anything!



Example : Gender & Typing CPS

- What can we say from descriptive statistics?

	Male	Female
1	1.89	2.39
2	1.82	1.86
3	7.12	1.82
4	2.30	2.34
5	1.66	1.94
6	1.84	2.01
7	1.80	2.28
8	1.45	2.06
9	1.54	1.91
10	1.72	2.07
Average	2.314	2.068

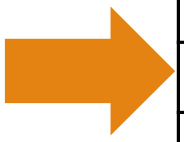
Example : Gender & Typing

- If we perform a paired t-test
- $p = 0.67 > \alpha = 0.05$
  - No significant difference between the conditions
  - We cannot conclude anything

	Male	Female
1	1.89	2.39
2	1.82	1.86
3	**7.12**	1.82
4	2.30	2.34
5	1.66	1.94
6	1.84	2.01
7	1.80	2.28
8	1.45	2.06
9	1.54	1.91
10	1.72	2.07
Average	2.314	2.068

Example : Gender & Typing

- Let's assume we draw a different sample
- p = 0.028 < 0.05
  - Significant difference between the conditions
  - Typing speed results for female higher CPS than male
- One outlier between rejecting and accepting H0 indicates a weak statistical power!
- To increase power?



	Male	Female
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2	1.82	1.86
3	**2.30**	1.82
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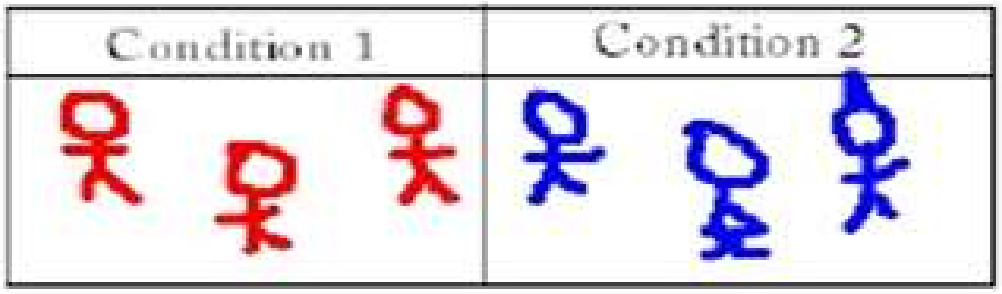
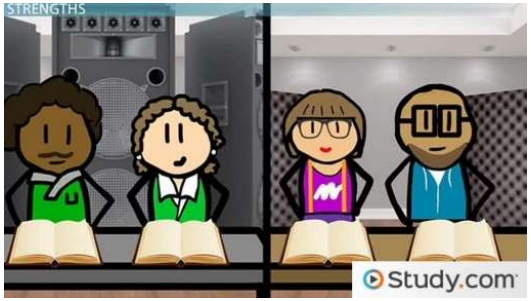
6	1.84	2.01
7	1.80	2.28
8	1.45	2.06
9	1.54	1.91
10	1.72	2.07
Average	1.832	2.068

Experimental research: Between Subjects

Independent Two Groups of test users:

Each group uses only 1 of the systems





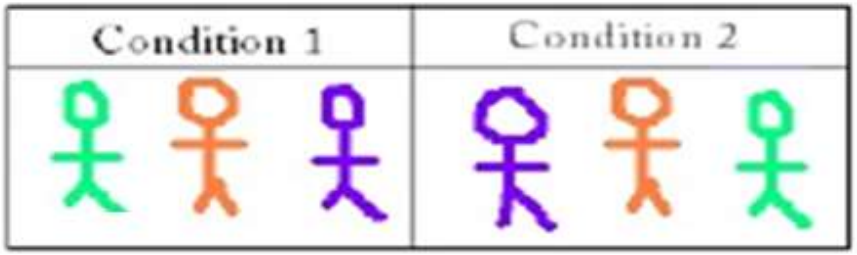
e.g. A/B testing

Independent sample t-test

Experimental research: Matched Pairs

Matched Pairs:

Matching each participant with someone who is similar to them, and placing them in different conditions.



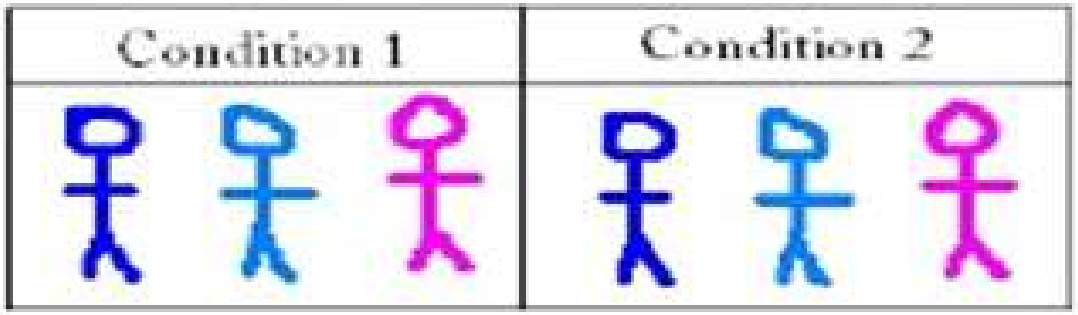
e.g. Old version vs New version of a Web site

Dependent sample t-test

Experimental research: *Within Subjects*

One group of test users

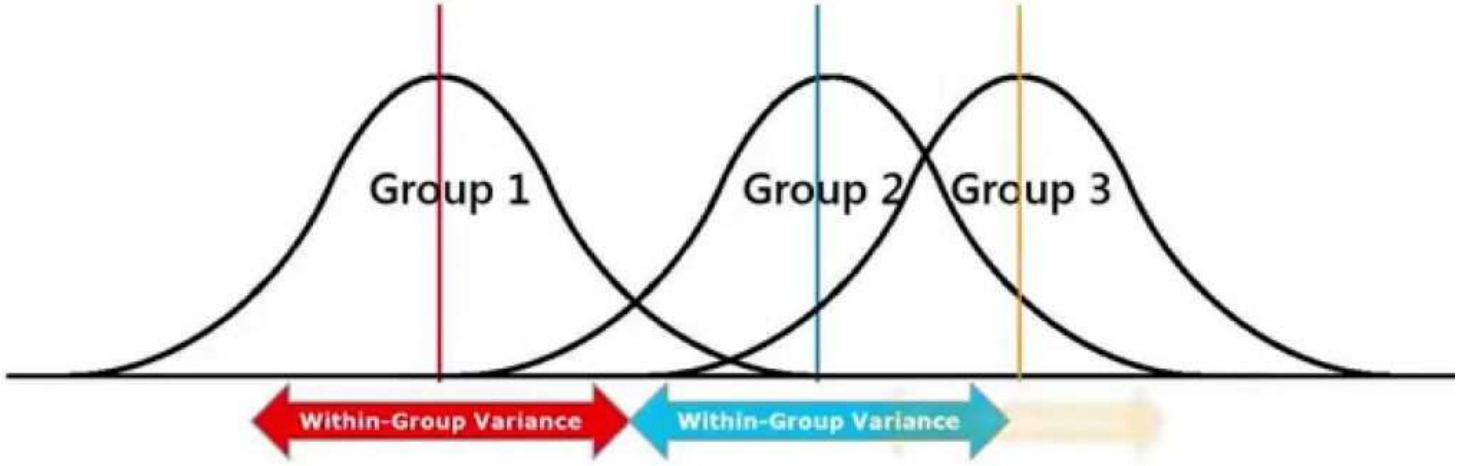
Each person uses both systems



Dependent sample t-test

Analysis of variance ("ANOVA")

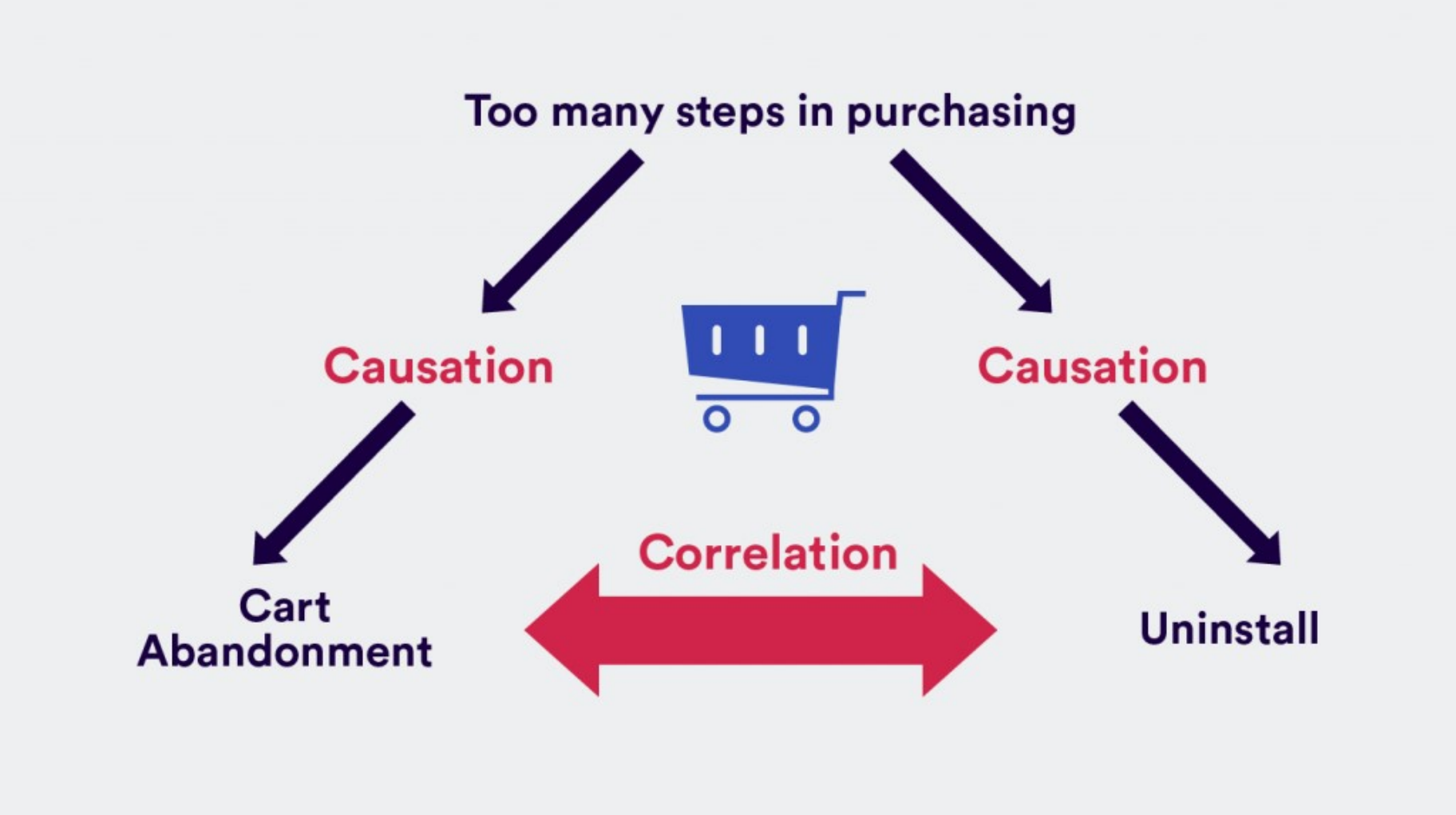
- the inferential statistic indicating the presence of a significant difference among the means of ***three or more groups***



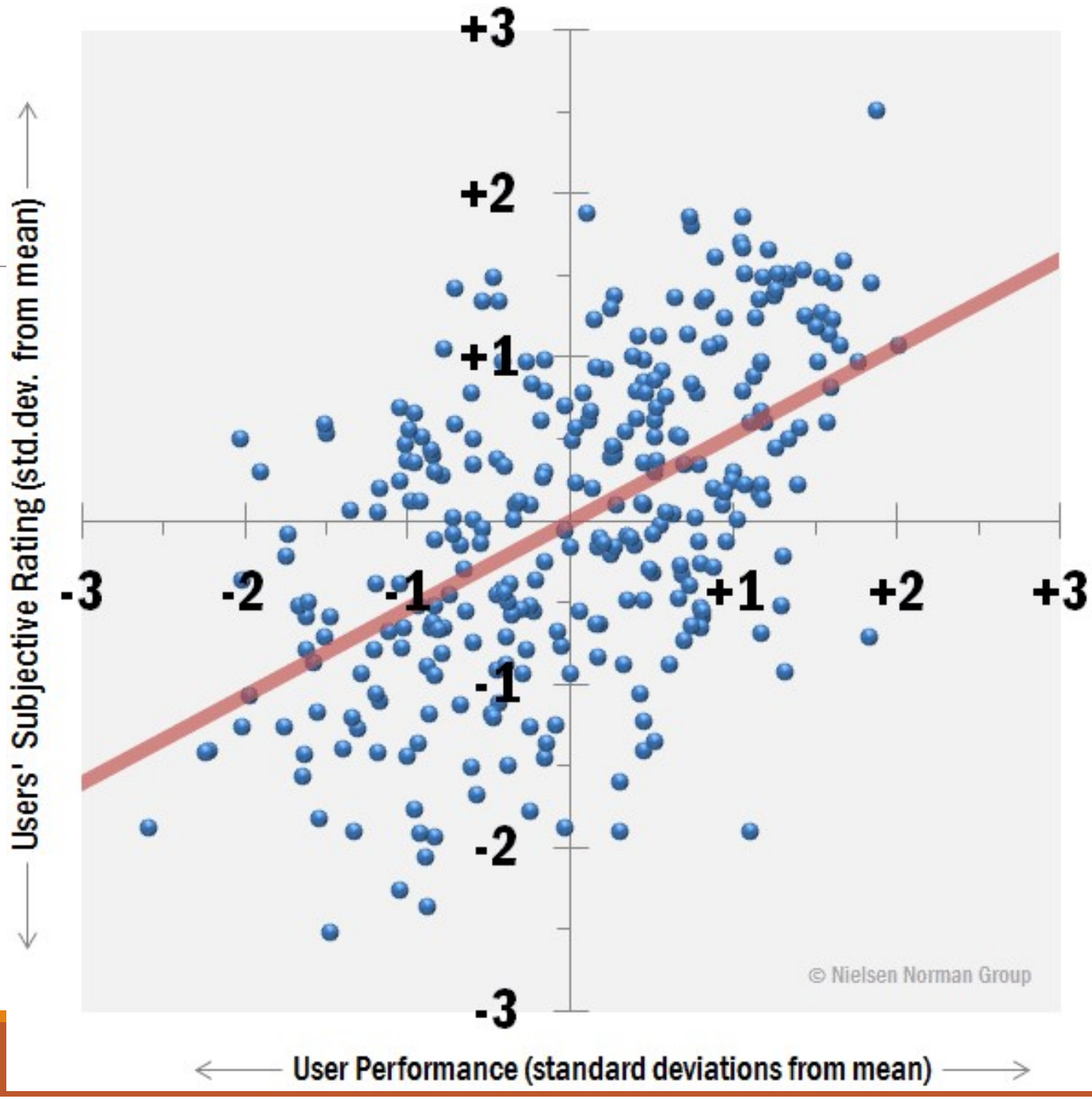
Correlation

- The relationship between two variables of degree.
  - Positive: As one variable increases (or decreases) so does the other.
  - Negative: As one variable increases the other decreases.
- Magnitude or strength of relationship
  - -1.00 to +1.00
- Correlation does not equate to causation

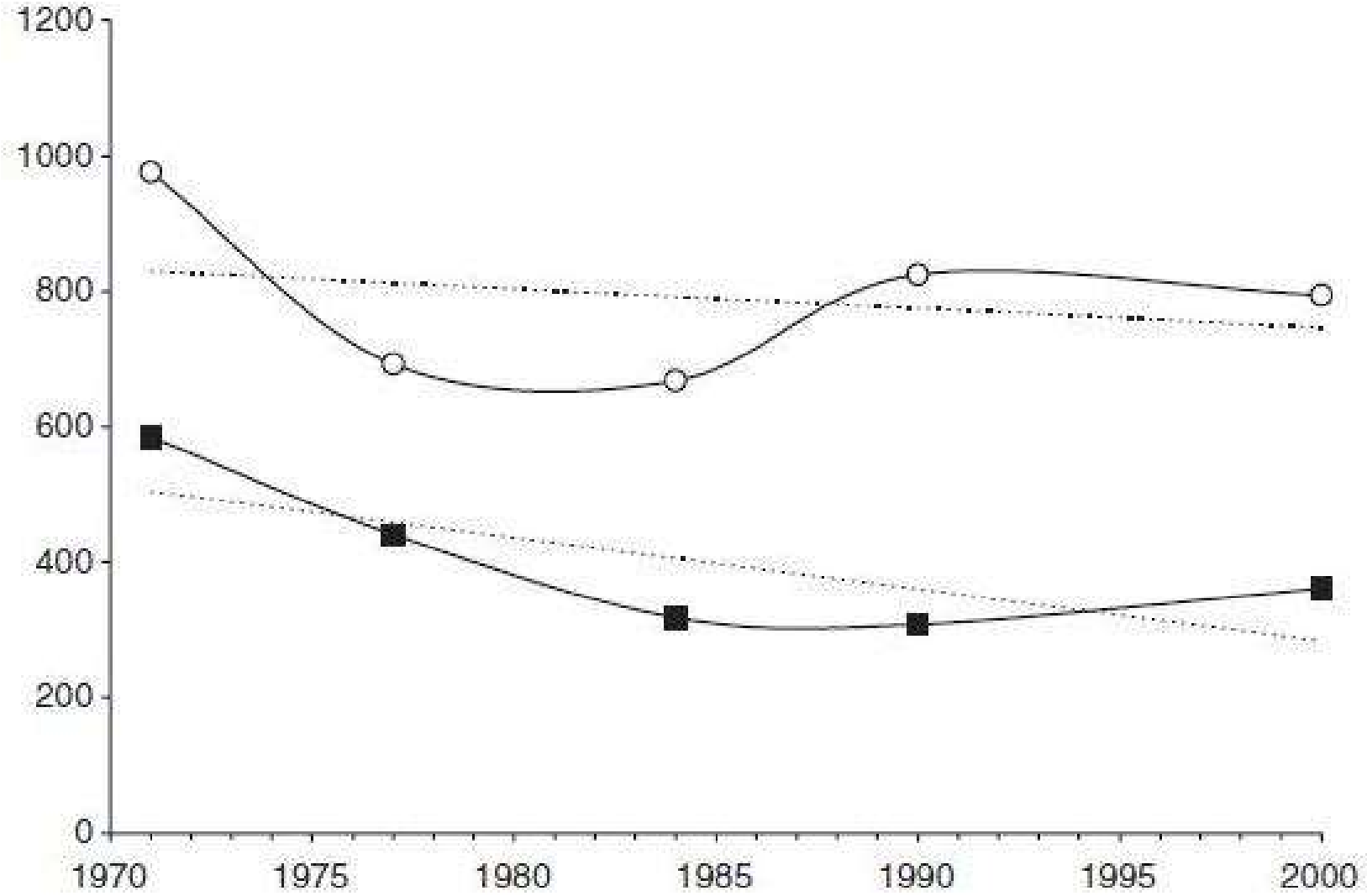
Correlation Studies



Correlation Studies



Correlation isn't Causation



Correlation isn't Causation

Example: Storks and birthrate

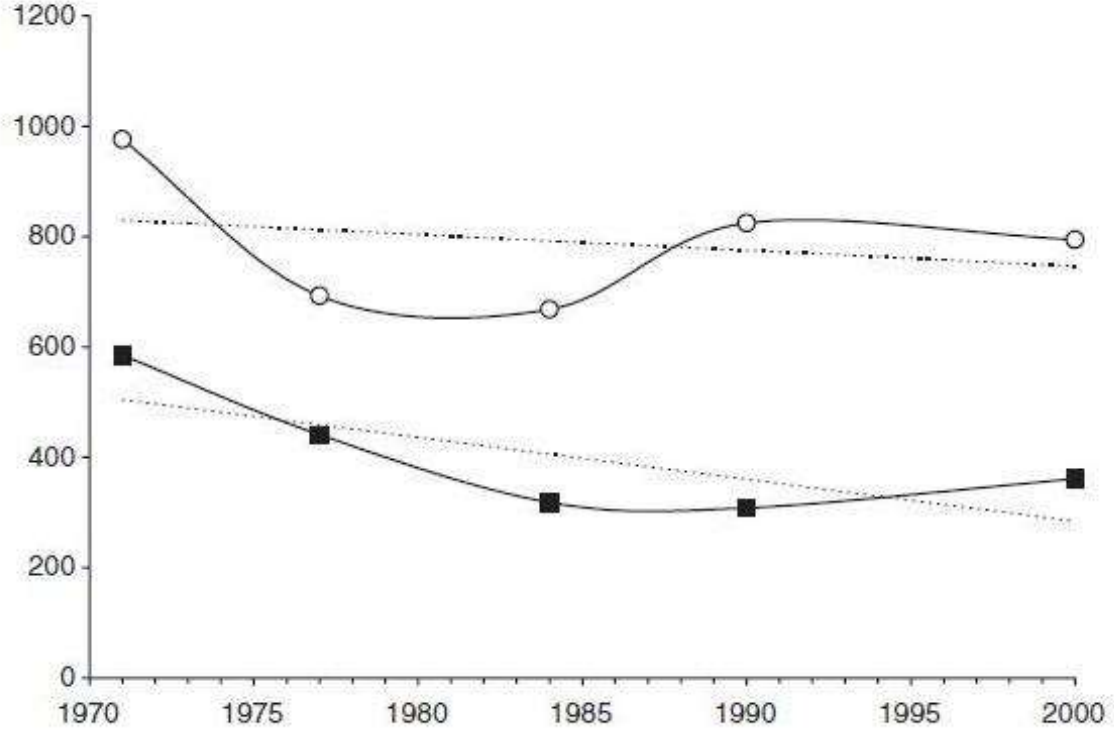
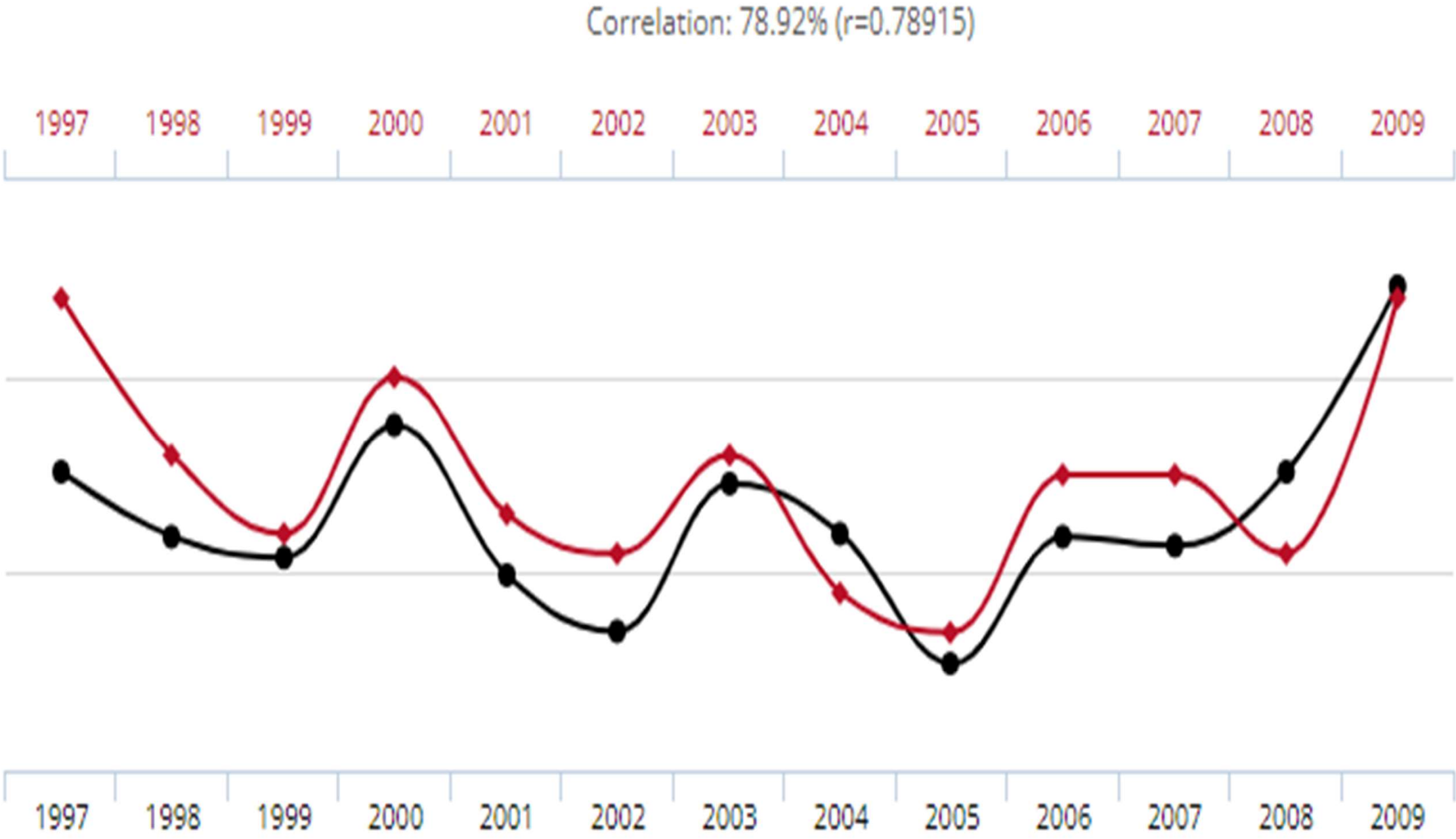


Figure 1. Storks and the birth rate in Lower Saxony, Germany (1971–2000). Open circles show yearly birthrates in hundreds in Lower Saxony. Full squares show numbers pairs of storks in Lower Saxony. Dotted lines represent linear regression trend ($y = mx + b$).

Matthews, R. (2000), Storks Deliver Babies (p= 0.008). Teaching Statistics, 22: 36-38. doi:10.1111/1467-9639.00013


Correlation: 78.92% (r=0.78915)
1997
1998
1999
2000
2001
2002
2003
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2007
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1997
1998
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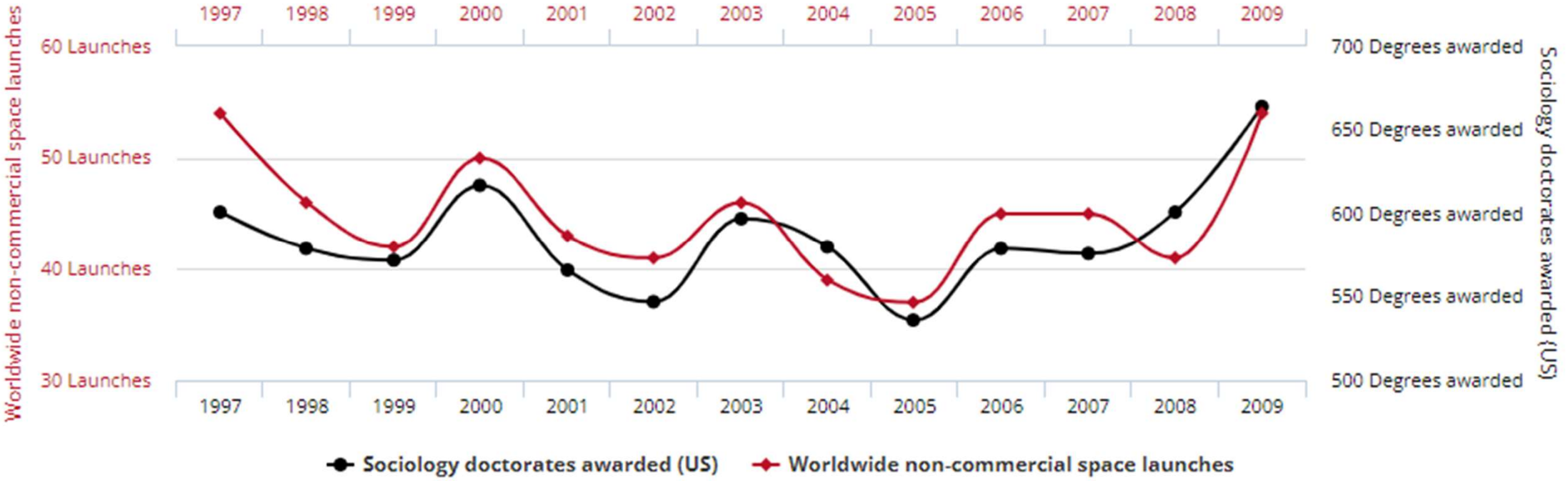
2004
2005
2006
2007
2008
2009

Worldwide non-commercial space launches

correlates with

Sociology doctorates awarded (US)

Correlation: 78.92% (r=0.78915)



Internal Validity: accurately measure the relationship between the variables ?

- Identification, documentation, and elimination of confounds
- High, when there are no alternative explanations for your results
  - The variation of your dependent variable is caused by the variation of your independent variable
- Low, when there are experimental effects can be explained through confounds, bias, history effects, maturation, etc
  - The variation of your dependent variable can by explained by the variation of confounds
- We aim for high internal validity
- e.g. Usability testing of Akbank vs Vakıfbank with Sabancı students?

External Validity

- The extent to which results can be generalized
- High, when results of the study can be transferred to the real world
  - e.g. does the sample represent the general population?
- Low when the results cannot be applied to the population or real-life situations outside of the research setting

  → ecological validity

Next Week


Week-12: Accesibility
URL
An advanced approach to accessibility (US Government resource)
URL
W3 Accessibility
URL
Web Content Accessibility Guidelines (WCAG) 2.2
URL
Web for everyone: It was a dream, it remained a dream! (In Turkish)
Assoc. Prof. Yavuz Inal's IECHCI keynote talk